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Remote Automatic Multipurpose Station

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TECHNICAL SUMMARY

During the past report period, the field test hardware was fabricated and installed at the field test site. Because of coordination problems at NARL, the planned field test had to be modified and installation of the RAMS system was made at NARL instead of the DEW line site PIN MAIN.

The RAMS field test system consisted of the following: an FSK, SSB modulator capable of operation in the three selected bands of 4 to 5 MHz, 6 to 7 MHz and 8 to 9 MHz; a broadband 100 watt, solid state power amplifier; an antenna coupling network; a DDRR antenna; an Accutron timer; and a propane powered motor generator.

The thermoelectric (TE) cell power source was also installed at the field test site.

The initial tests were encouraging and the RAMS signal was received at T3 approximately 1100 nautical miles away.

Problems then developed with the propane motor generator and the RAMS system was switched to the TE cell power source. Again initial tests were good and contact was made with T3. The timer was not usable with the TE cell and the equipment is now being operated manually by a NARL volunteer. An initial report after the field crew left indicated that a problem had developed, however, it turned out to be an operator error. After approximately two months, the equipment is still operating.

TECHNICAL RESULTS

Frequency Selection

As indicated in the last report, three frequency bands were chosen for RAMS operation. These were the 4 to 5 MHz band, the 6 to 7 MHz band and the 8 to 9 MHz band. Initial testing will be done in the 6 to 7 MHz band only. A Preliminary frequency of 6.544 MHz was used for the field tests but now a set of permanent frequencies have been assigned and the field station will be shifted to the new frequency in the 6 to 7 MHz band. The assigned frequencies are 4.1605 MHz, 6.221 MHz and 8.318 MHz.

Transmitter

The design shown in the last technical report was fabricated. The completed equipment was temperature cycled over a range of -20°C to +50°C and performed very satisfactorily. The equipment provided a full 100 watts output over the temperature range with an overall efficiency of approximately 50%.

Power Supply

A timer and control unit was designed and fabricated for the propane fueled motor generator which was selected as the primary power source. The timer provided a turn-on of four minutes every four hours and was actuated by an Accutron watch. The motor generator control unit provided the following functions: turn-on starter motor; turn-off starter motor when motor started; provide delay before restarting in case starter clutch was disengaged and provide a timed charge of propane into the carburator before each start. The thermoelectric generator was refurbished, tested and prepared for shipment to the field test site.

Antenna

The three candidate antennas (Turnstile, DDRR and Vertical) were modeled at an amateur radio frequency of 7.25 MHz to obtain comparative data. Data were obtained by listening to stations, identifying them and then obtaining their position. For comparison purposes, ranges were classified as short, 300 to 400 miles; medium, 500 to 600 miles; and long, 800 miles and over. The Turnstile provided the best performance at short and medium ranges and the DDRR appeared best at the long range. The Vertical was slightly better than the DDRR at the short range. The DDRR was within 3 dB of the Turnstile at the medium range and within 4 dB of the Turnstile at short range. Because of the favorable small horizontal profile and good mechanical qualities of the DDRR, it was decided to select it as the RAMS antenna. A picture of the installed DDRR antenna is shown in Figure 1.

Field Test

The field crew arrived at NARL on 14 November. The electronics equipment arrived the morning of 16 November. Delays were encountered in the installation because of coordination problems at NARL. The housings that had been made were not of the proper configuration and arrangements could not be made for set-up of the RAMS at PIN MAIN. To expedite the field test it was decided to use the existing housing which could be obtained in a few days for the basic RAMS station and to have the correct configuration built for the TE cell test system. Since the available housing was about twice as big as the desired one, it had to be modified by sealing off a portion of the box for interior temperature control. In addition since PIN MAIN was unavailable, the decision was made to install the RAMS station at NARL and receive it at T3, approximately 1100 nautical miles away. This will give us data on the long range propagation characteristics but it will still be necessary to find suitable sites for determining short and medium range characteristics. The modified housing was received on 18 November and the installation of the propane bottles, generator and transmitter was completed on the 19th. The system was set to cycle and temperature readings were taken. With an outside temperature of -20°C, the following readings were typical.

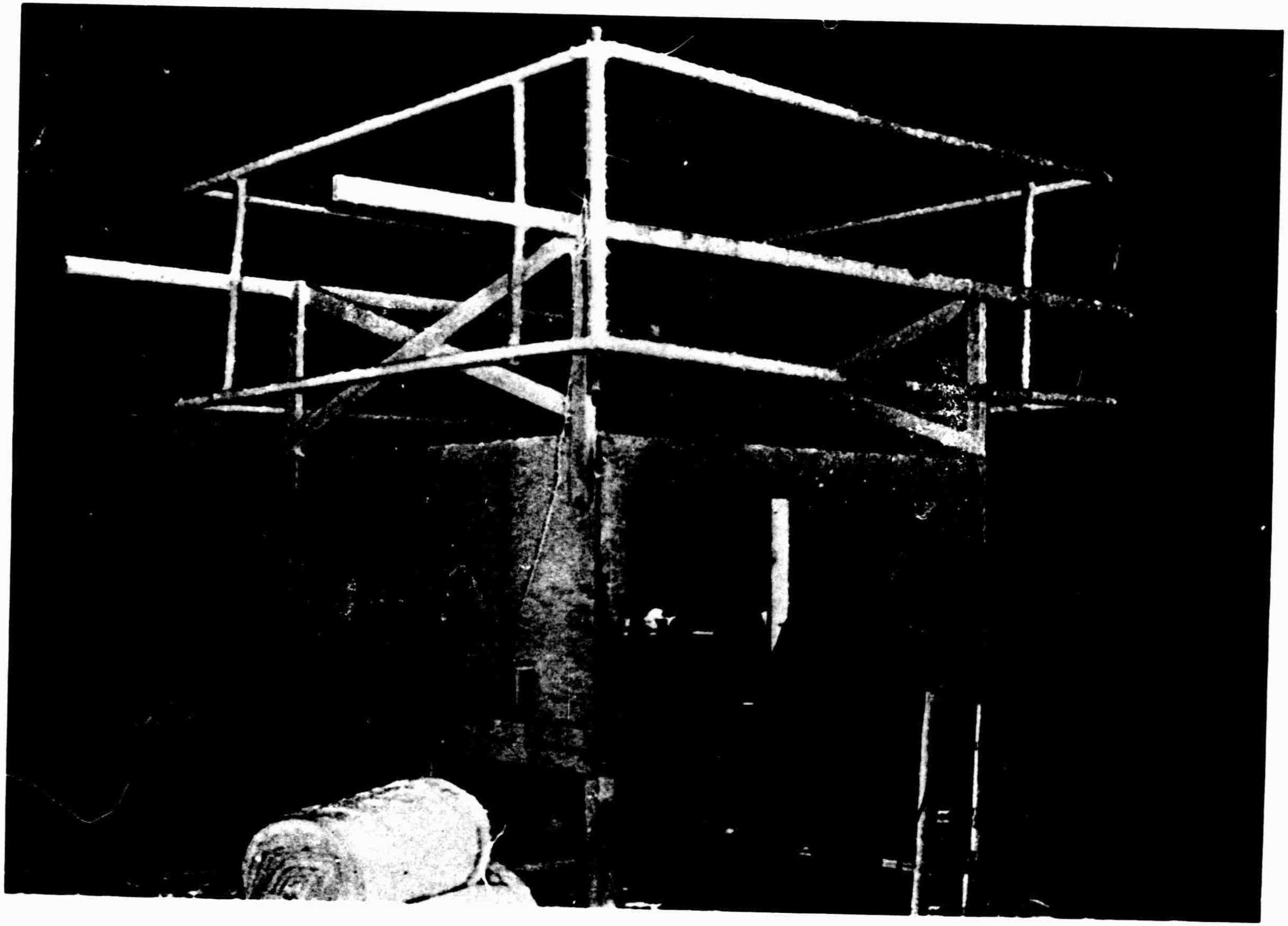

Figure 1. DDRR Antenna Installed on Oversized RAMS Housing

	Top of Housing	Midpoint in Housing	Bottom of Housing
Before cycle	$0^{\circ}C$	$+3^{\circ}C$	$-6^{\circ}C$
After cycle	$23^{\circ}C$	$23^{\circ}C$	$48^{\circ}C$

The goal was to maintain the midpoint temperature between $50^{\circ}C$ and $-10^{\circ}C$ over an outside temperature range of $-45^{\circ}C$ to $+15^{\circ}C$. The measured differential was about $23^{\circ}C$ thus more insulation or a higher heat input would be required. A 1000 watt immersion heater was used in the above measurements and a larger one was not available. Since this was a temporary housing and the temperature was within the limits, it was decided not to work on improving the temperature differential at this time.

The system missed a cycle at 11 pm for unknown reasons and completed four cycles successfully during the evening. The system started malfunctioning the next day and it was discovered that several problems had occurred simultaneously. The generator had become depolarized, a logic IC chip had failed in the timer and the motor was not getting sufficient cylinder lubrication and was seizing up. The piston was freed with WD40, the logic chip replaced and the generator repolarized. The antenna was installed and the system started. A good strong signal was received at T3, approximately 1100 nautical miles away, indicating that the transmitter power and antenna were adequate for the long range path. Problems continued to plague the power supply and after a propane hose cracked, the propane regulator cracked, the motor seized up again and the starter motor burned up, we exhausted our ability to repair it. Although the motor generator was an attractive power source since it had considerable excess power available for auxiliary functions, it is obvious that a better engineered, more sophisticated unit would have to be found, probably at a large increase in cost.

The system was then switched to the TE cell which was installed in the proper housing. A layout is shown in Figure 2 and the installed system in Figure 3. The TE cell was used to charge four 60 amp hr lead acid batteries which provided the peak current demands of the transmitter. This arrangement should conservatively allow operation of four minutes every four hours.

After adjusting the insulation and providing a vent at the top, a temperature differential of 45°C was achieved at the electronics location. Since the TE cell runs continuously this temperature differential is maintained. The control and timing circuit for the motor generator was not usable with the TE cell so arrangements were made to have the system turned on periodically by a NARL volunteer after the field crew left. Initial reports indicated the system was not working but this turned out to be an operator problem and was corrected. As of the date of this report, the TE cell has run continuously for two months and the rest of the system has been cycled intermittently and is still in good working order. Figure 4 shows a comparison of the TE cell RAMS housing with the oversized housing used for the installation of the propane motor generator system.

FUTURE WORK

An automatic control circuit has been designed and fabricated for the TE cell system. A trip will be made to NARL in February to install it and inspect the station.

Suitable receiving sites for medium and short range testing of the RAMS system must be located. Candidates at present are Wales for medium range and AIDJEX for short range. This area will be investigated further.

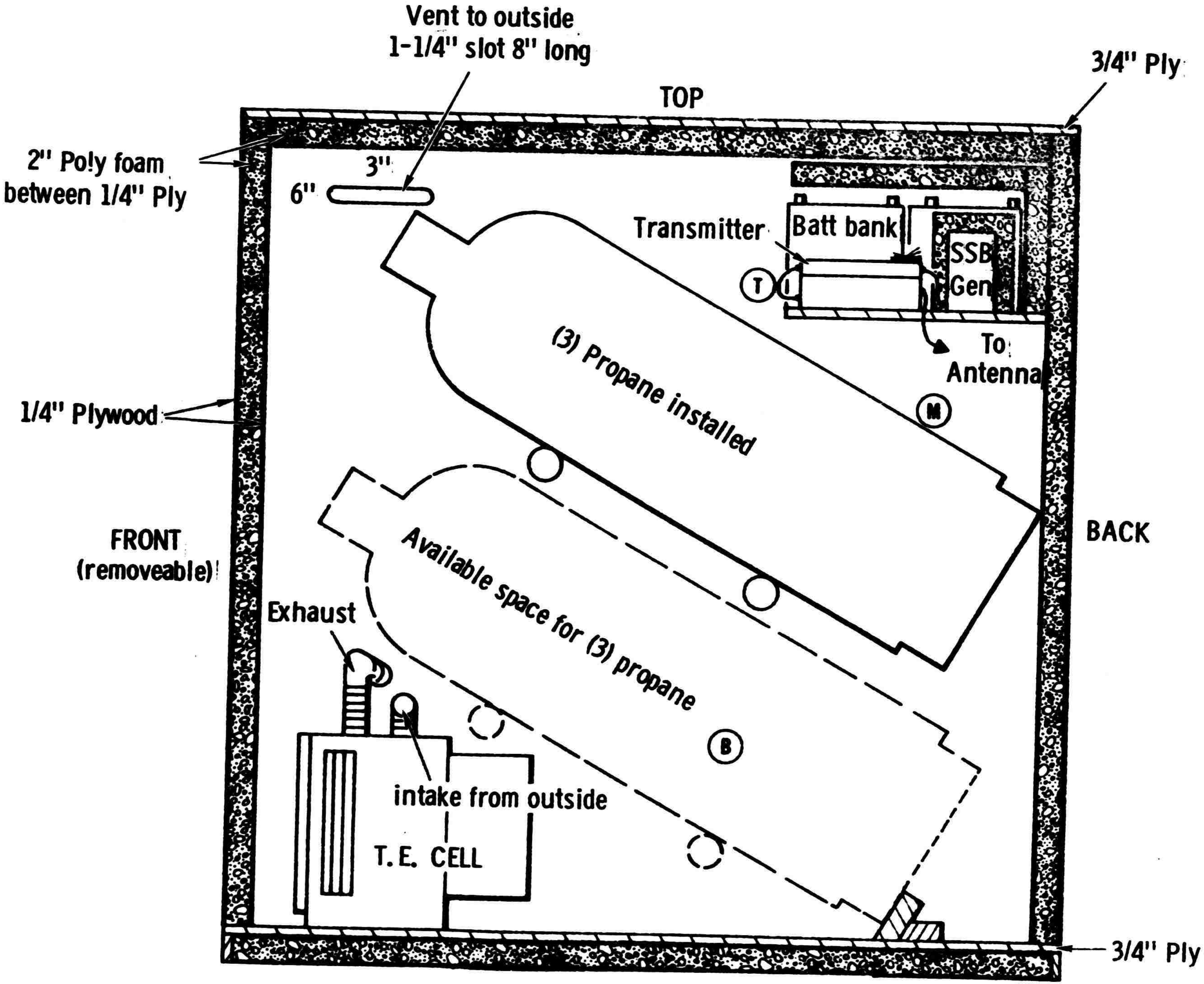

Figure 2. Layout of TE Cell RAMS Housing

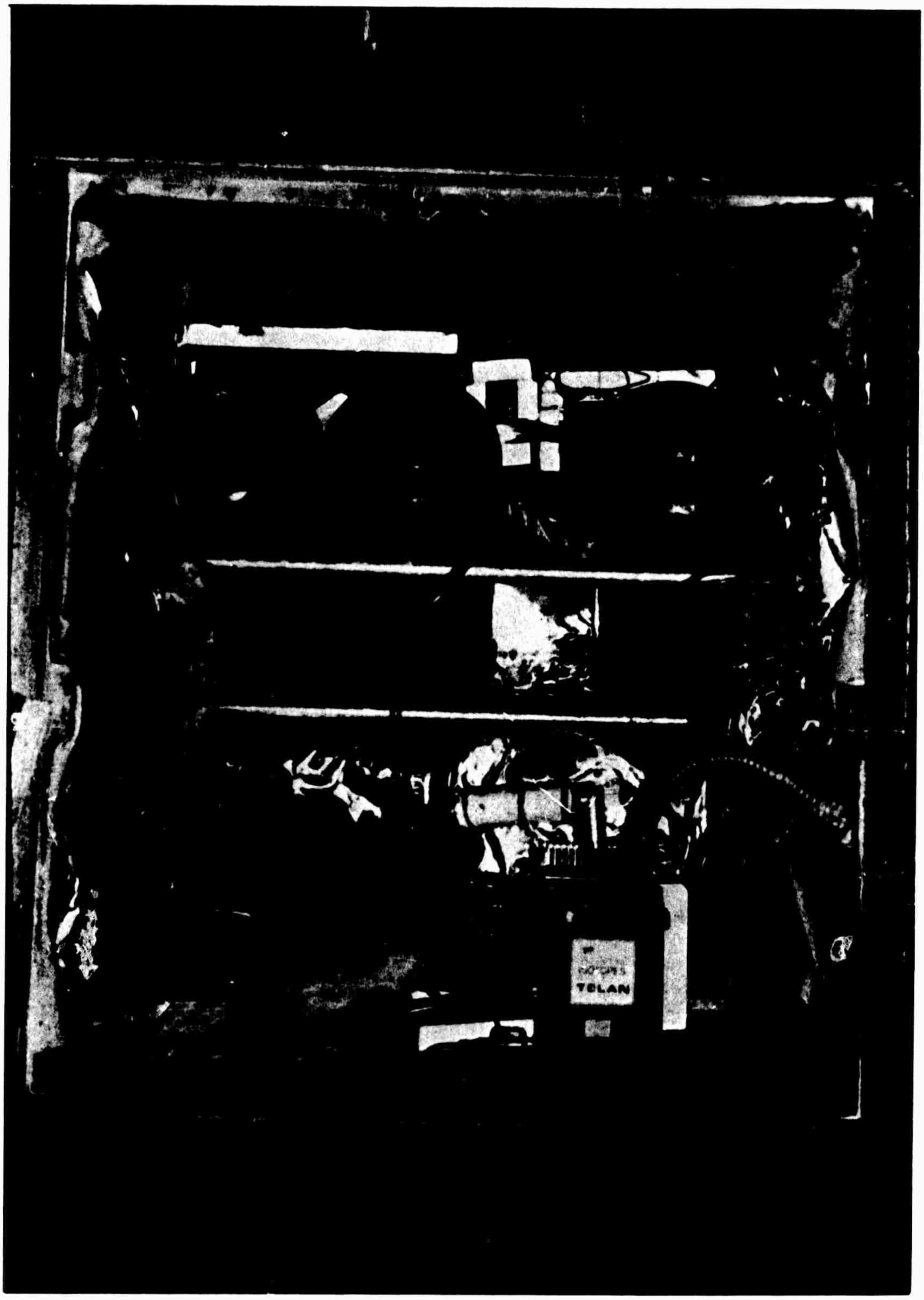

Figure 3. Equipment Installed in TE Cell RAMS Housing

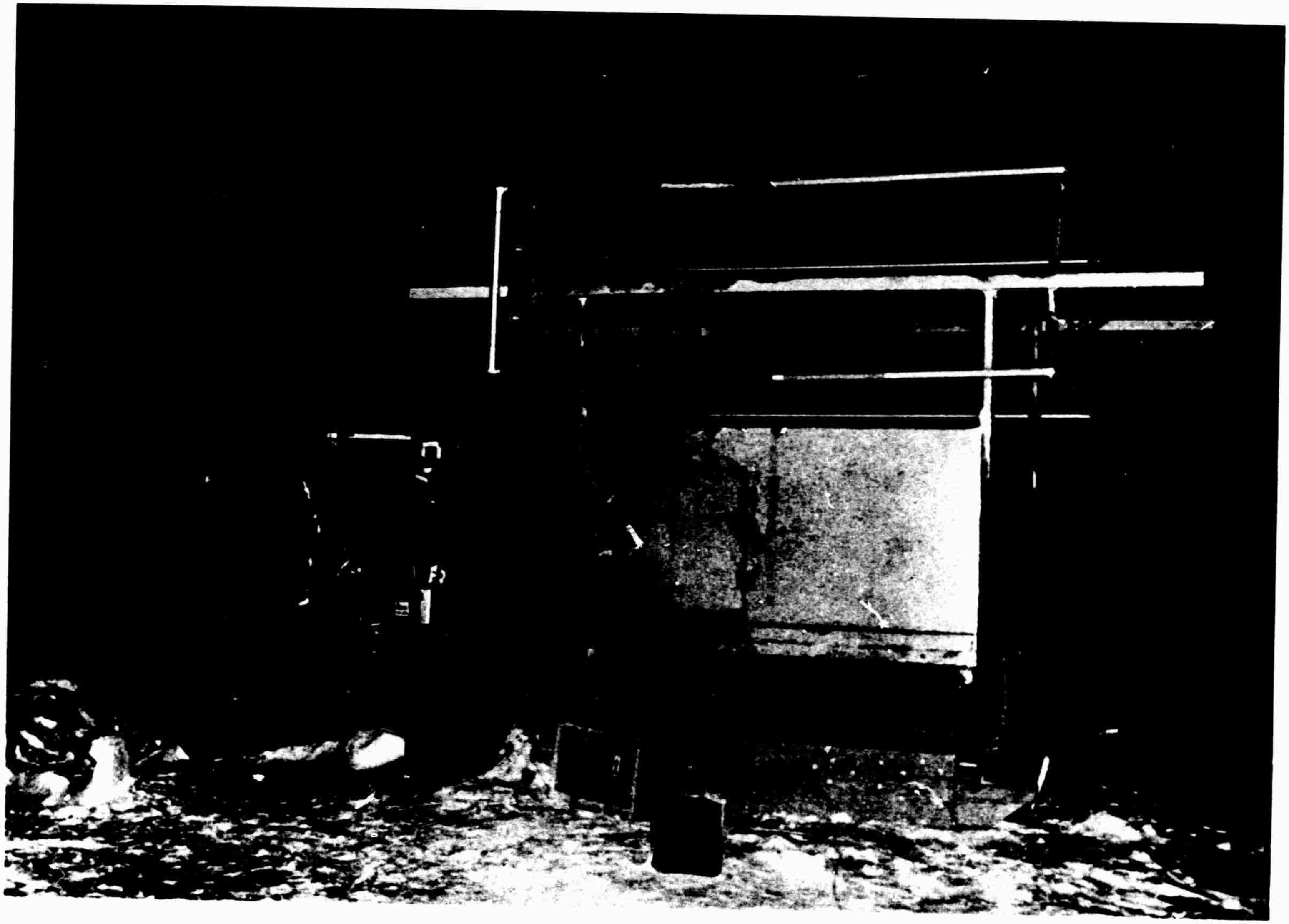

Figure 4. Comparison of TE Cell RAMS Housing with Oversized Housing Used for Propane Motor Generator Installation

At the first of the project, batteries of various types were considered for the prime power supply. At that time it appeared that the power requirements for a continuous and reliable flow of telemetered data exceeded the capabilities of available batteries. However, the development of a recirculating digital memory ("DELTIC") having the ability of considerable time compression and redundant data transmission, effectively reduced the total energy requirement of the power supply for the long-life RAMS system. Therefore, batteries are once more being considered for this function. Cold chamber tests of commercial "air cell" primary batteries and sealed lead acid secondary batteries could probably meet the requirements if the cells are buried one to two meters in the ice with a snow layer for insulation. A suitable watertight container with a snorkle breather tube will have to be developed but this poses no serious problem. The use of batteries would also obviate the safety problem inherent with propane fueled supplies and would, of course, be more reliable. Environmental tests in the Arctic are needed to substantiate the simulated (cold chamber) lab tests.

Some confusion has arisen recently concerning the use of the acronym RAMS. It is used extensively in the digital field where it stands for Random Access Memory and in the NIMBUS F satellite system as Random Access Measurement System. To avoid this confusion, it is suggested that the RAMS be changed to LORAMS for LOng Range Arctic Measurement Station.